WINDS AND STORMS AS AGENTS IN THE DIFFUSION OF INSECTS.[1]

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By the term "winds" I wish to include even the mildest breezes as well as the strongest gales, the latter, either alone or in connection with thunderstorms, such as may and ordinarily do occur in our latitude during the warm months of the year. Throughout the northern states the keen, biting March winds find comparatively few insects abroad to be caught up, or who willingly surrender themselves to its power; and in late autumn, when the breeding season is nearly or quite over with the majority of species, they seem to prefer the quiet of the Indian summer to move about. In the one case, diffusion appears to be the one overwhelming object; while in the other, the object seems to be to reach particular locations or conditions that will best protect from the winter blasts which are to come later on in the year.

Whatever conduces to diffusion, must, as a rule, tend to increase fecundity — first by bringing the sexes together during the mating seasons, and second by enabling them to secure a greater food supply.

The effect of even very light breezes in enabling the sexes to meet at the proper time may be well illustrated by placing a female of some of our larger moths in a wire cage, and, hanging this in the open, noting the number of males that will soon be attracted and remain hovering about the cage, making every effort to reach the female within. The same may be observed in many Hymenoptera. It will be noted further that these males come to the cage against and not with the wind. With a continual absolute quiet, how much less liable would the sexes be to reach each other at the proper time for mating,

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especially such as are wingless among the females, or which, having wings, do not readily use them? If we trap insects by baits or by lights, we find that our catches will be largely of males or spent females, thus showing that, generally speaking, the male seeks the female. In the cases of some of our hymenopters and especially where males do not, or rarely, occur, and with others, like the Aphides, where the males only occur at a single definite time, this rule will not hold good, and our captures will be all of them females; and I think it is among such that will be found those that give themselves most freely to the embraces of the winds during the breeding seasons.

The influence of the winds in enabling insects to detect the location of their food is apparent in many ways. If we place the dead body of a bird, snake, or small animal under a bell glass in the fields, no carrion-loving insects will come to it; but if we substitute for the bell glass a wire cage, these will soon find their way to it, coming against and not with the wind. The two species of dung beetles, *Aphodius inquinatus* and *A. serval*, which appear, the one in the fall and the other in the spring, quickly find the fresh droppings of animals by aid of the wind. The plum curculio, *Conotrachelus nenuphar*, is said to approach a plum orchard more readily against the wind than with it, as has been determined by painting individuals and liberating them to the windward and leeward of a plum orchard just at the season for oviposition; and there is little doubt but that many of our wood-boring beetles are enabled to select a weakened tree by their acute sense of smell. Thus do the light winds enable many insects the better to find their food and each other, thereby greatly increasing their numbers in any given place.

The high winds and gales, unaccompanied by rain, thunder, and lightning, also exert a powerful influence in the diffusion of insects. But before taking up the direct subject of influences of high winds exclusively, it may be well to call attention to some of the effects of prevailing winds, that is, winds both light and heavy but which come most continuously from one direction during the period when insect diffusion is most susceptible to their influences. A most convincing illustration in

this direction is offered by the spread of the San José scale in orchards, especially in the Middle West. If infested trees, brought from the nursery and transplanted to the orchard, happen to be set along the north or east margins of an orchard, the spread through that orchard is comparatively slow; but on the other hand, if the infested trees happen to be placed along the west or south margins, the progress is much more rapid. So also, where the introduction is into a section of country largely devoted to tree fruits, the spread over the country is much more rapid towards the northeast than in any other direction. This is for the reason that our prevailing winds, during the period when the young are carried from one place to another by these winds, blow from the southwest or west, more generally the former. In the case of the Hessian fly, *Cecidomyia destructor*, I have noted that, where a field of wheat has been seriously attacked in the fall, and adjoining fields have escaped, some of these last may be seriously attacked the following spring, while others seemingly equally exposed to attack almost entirely escape injury. A careful examination into the facts, however, will show that this is due to the direction of the prevailing winds at the time when the spring brood of flies were abroad, and the wind simply carried them toward those fields that were located in one direction and away from those located in the opposite direction, thereby to a certain extent protecting the one from attack and causing the destruction of the other. In the case of the San José scale, active only in the very young larva, I have noted that, where infested trees happen to be placed in a gully extending up a steep hill, the spread will be much more rapid upward than downward, as the air current is in that direction. So, then, prevailing winds have in some cases much to do with the spread of insects in certain directions. The influence of high winds on insects is illustrated in one way by the great number of butterflies that are sometimes encountered by ships at sea, long distances from land. Indeed, the entomological fauna of very many of the islands of the sea indicates very strongly that insects have become established on such islands by having been blown from the mainland, or from other islands located at considerable

distances away.[1] Dr. Henry C. McCook, in his great work on *American Spiders and their Spinning Work*, has shown how the huntsman spider, *Heteropoda venatorius*, on account of its aeronautic habits, might well have circumnavigated the globe with the aid of the trade winds, basing his calculations on the localities where the spider is known to occur and the direction of these winds. The late Dr. D. S. Kellicott told me of the sudden appearance of considerable numbers of the cotton-worm moth, *Aletia argillacea*, at Columbus, Ohio, immediately following a gale from the southwest; and, besides, we know that this moth has been found as far north as western Ontario, with no evidence of its having developed there in a single instance. Years ago, while studying the habits of the buffalo gnat, in the Southern States, one of the most perplexing questions that confronted the planter, relative to the habits of this bloodthirsty insect, was their sudden appearance in a locality in such immense swarms as to kill thousands of head of cattle, mules, and other domestic animals, before these could be gotten to a place of safety. Early in my investigations, I found that the adult gnats emerged from the waters of the bayous and clustered upon the surrounding vegetation in such numbers as to fairly cover the same, and a sudden high wind would carry these gnats along with it and distribute them for miles over the cotton plantations, there to carry on their bloody work. Thus, these insects might appear suddenly in immense numbers, ten or twelve miles from their place of breeding, in one direction, while in the direction opposite they might not occur

[1] Since the preparation of this paper the following note has come to me:

The 'Blue Page' Moth. — During the gale that reached Barbados and St. Vincent on August 26, 1901, numbers of a large moth were found in Barbados, of a kind not known to breed there. They had evidently been brought by the high southwest wind. Some were caught and identified as *Urania sloanei*, the 'blue page' of Trinidad, and they had apparently come from the mainland or, more probably, from Trinidad itself. They were found as far north as Dominica, and one was caught on the R. M. S. 'Eden' midway between St. Lucia and Barbados. This is an excellent instance of how insects spread from island to island, and had these moths found suitable conditions in Barbados, they might have become established there and formed an addition to the permanent fauna. The direct distance from Trinidad to Barbados is about 160 miles, and to Dominica is some 100 miles more. — *The* (Barbados) *Agricultural News*, June 7, 1902.

at all, — the direction depending on that of the wind ; and a wind prevailing from the same direction during the breeding season one year would affect a certain territory, while the following year the prevailing winds might be from another quarter, and so cause these insects to terrorize an entirely different section of country. Formerly, and before the advent of the electric motor as a means of propelling street cars, when these gnats developed, during some seasons, in the St. Francis bottoms, across the Mississippi River west of Memphis, Tenn., these insects might occur in their breeding grounds in immense swarms, but so long as the prevailing winds were from an easterly direction few of them would be observed in Memphis ; but let a strong gale set in suddenly from the west and these bloodthirsty insects would suddenly appear in such numbers as to prevent the running of the street cars, which were then drawn by mules ; these last would be killed in their harnesses, and the cars were necessarily abandoned until these gnats disappeared. Of course the introduction of electricity, and the disappearance of the mules as a means of motive power has, in this case, overcome the difficulty, but former conditions offered a good illustration of the far-reaching influences of the wind on some insects. It may be mentioned that the gnats that were so driven about by the wind were all sterile females and the species was not, in this particular case, permanently diffused by this means. Somewhat similar effects of winds are to be observed as affecting the various species of migratory locusts, the exact territory devastated by them often being dependent on the direction of the prevailing winds during the migrating season.

Relative to the concluding point in this paper, *viz.*, the influence of wind and thunderstorms combined on insect diffusion, I beg to call attention to a most interesting series of papers contributed to *Prometheus*, a German scientific journal much like our *Scientific American*, by Prof. Karl Sajö, of Budapest, Hungary. Professor Sajö says that it is known that "before thunderstorms the crayfish come out of the water into the grass on the banks of the river or lake ; many fishes act as if they were insane, and many birds and mammalia become

irritated and angry. Even the micro-organisms are subject to similar changes; for instance, before thunderstorms in late fall, the wine fermentation can reach so great a violence as to cause the fermenting juice to suddenly run out of the vats. The greater the change in the atmosphere, the greater the unrest of the living being." If one happens to be at a farmhouse in our own country, where ice is not freely used, and a thunderstorm occurs, any farmer's wife will complain that the thunder and lightning have soured the milk. Continuing, Professor Sajö calls particular attention to the "great unrest and activity that takes place in the insect world just in the sultry hours preceding a thunderstorm, and to the fact that insects in the air at the time the storm bursts are driven like chaff to great distances, — perhaps into other countries, across rivers, lakes, and mountains; not only the species that fly but many that do not fly may thus be transported to new homes." And again, "Many Aphides creep to the crowns of the plants, then drop themselves at the proper moment into the violent current of the storm. A number of these insects land in places where there is no food supply for them and they die. A part of them reach places where their species is already established, and fare no better. Part are thrown into the water, sometimes in oceans, and perish. A proportionally small number arrive at such places as may be called really favorable for their diffusion, *viz.*, where the species has never established itself before, or, having done so, died out before the arrival of newcomers, and, therefore, natural enemies had not preceded them. Such individuals as are thus thrown into favorable places have a chance to multiply into large, populous colonies within a short space of time, and continue until their enemies find them out, or they become over-populous and devour all of their food supply, resulting in what to them is famine."

There is probably not an American entomologist who has not encountered illustrations similar to those enumerated by the writer of the above, and, while we may not have wholesale introductions of new things among us, there is no doubt that localities are often first colonized by certain kinds of insects in this manner, whereas the wind or the

thunderstorm acting separately would not bring about such a condition of affairs.

I have stated that, in applying trap lights or lanterns, or edible baits like sweetened sour beer, we, as a rule, secure males and spent females, but the influence of weather conditions that usually precede a thunderstorm (that is, a close, sultry condition) has the effect of bringing out both sexes, — a result due, so far as can now be determined, to some subtile action on their sexual life. As Professor Sajö so aptly illustrates this point, I will quote him again quite fully. "What influence the weather has, especially on the activity of sexual life, must be known to every zoölogist; even man is not an exception from these 'living barometers.' Not only children, not only the female sex, but the sick ones experience the influence of the weather on the functions, especially on the nervous system; and everybody without exception are thus influenced, though not all may be aware of the fact. The same causes that in many produce unrest and irritation render others dizzy, stupid, or sleepy, according to the temperament of the individual." The effect of electricity on the nervous systems of insects, especially as relative to their love affairs, would constitute an interesting study, and one that ought to be carried out; but even as it is, we can see that the thunderstorm, in conjunction with the wind, may accomplish in the diffusion of insects that which neither element alone would bring about.